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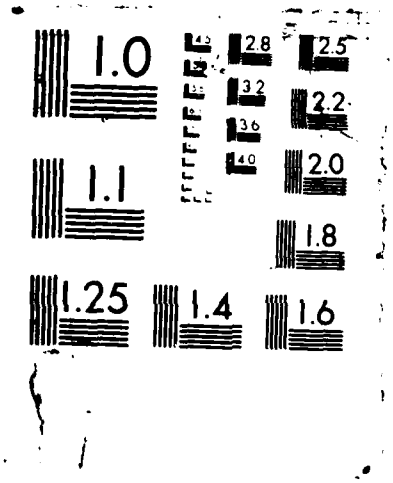
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AFGL-TR-87-0253

Engineering Support of Space Shuttle Experiment Integration

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11 November 1987

Final Report
11 August 1983-11 August 1987

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
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DAPS (DUAL AXIS POINTING SYSTEM)
CIRRIS-1A (CRYOGENIC INFRARED RADIANCE INSTRUMENTAITON FOR SHUTTLE)
ESS (EXPERIMENT SUPPORT STRUCTURE)

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

THE FINAL REPORT DESCRIBES THE ACTIVITIES WHICH WERE PERFORMED TO FULFILL THE SOW TASK ITEMS OF F19628-83-C-0156

FOREWORD

Summary. This contract final report summarizes the work accomplished as required to fulfill the provisions of Contract No. F19628-83-C-0156.

Preface. This final report communicates the work which was performed based on the contract Statement of Work (SOW). The SOW lists 10 task items. Some task items were not completely fulfilled due to NASA delays concerning the Space Shuttle Program.

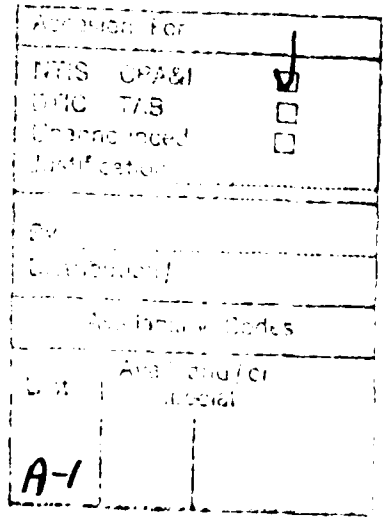

TABLE OF CONTENTS

1. INTRODUCTION

1.1 General. This final report summarizes the work completed on Contract No. F19628-83-C-0156 for the time period 11 August 1983 through 11 August 1987. The contract SOW included the following tasks.

a. SOW Contractor Tasks:

1. Assist the AFGL CIRRIS Program Manager in coordinating the CIRRIS integration efforts of AFGL, Utah State University (USU), USU subcontractors and the Space Vehicle Integrating Contractor (SVIC). Establish a central point of contact for all SVIC inquiries. Identify SVIC experiment interface requirements including detailed electrical and mechanical connections, electromagnetic interference constraints and failure modes analysis required to reduce risk of failure and to insure shuttle safety. Coordinate interface meetings between AFGL and the SVIC. Develop and maintain the experiment/shuttle interface definition. Maintain a current working file of SVIC environmental specifications. Task to be completed by launch.

2. Calculate the CIRRIS mass properties and electrical power requirements. Update these requirements as required by the AFGL CIRRIS Program Manager and generate any dynamic and/or thermal analytical models of the experiment that are specified by the SVIC for use during integration analysis. Task to be completed by CIRRIS-1A delivery of SVIC.

3. Develop a CIRRIS experiment drawing tree and parts list for use during testing and integration. The drawing tree and parts list will be updated as required by the AFGL Program Manager and shall be maintained on file with the support contractor. Task to be completed by launch.

4. Identify shuttle documentation requirements and assist the AFGL Program Manager in originating documentation required for successful CIRRIS shuttle integration. Task to be completed by CIRRIS 1A delivery of SVIC.

5. Review shuttle and SVIC documentation and regulations; determine their applicability to this experiment. Become familiar with the engineering procedures, applicable regulations and facilities at AFGL and SVIC, test sites and launch/recovery sites. Task to be completed by CIRRIS-1A delivery of SVIC.

6. As required by AFGL, originate detailed test plans and procedures to evaluate component and systems performance. The test plans and procedures will reflect the environmental test specifications now being developed by AFGL. A current file on all approved test plans and procedures shall be maintained by the engineering integration contractor. All test plans/ procedures shall be listed in the R&D Status Report IAW the Contract Data Requirements List, Attachment No. 2. (Note, this line item was deleted September 1985.)

7. Provide engineering test support at all test sites. The engineering test support shall include, but not be limited to, providing a test conductor, monitoring component/system performance, initiating necessary failure reports, analyzing results, and writing test reports. Test reports will be approved by the AFGL CIRRIS Program Manager. All approved test reports shall be listed in the monthly R&D Status Report required by the CDRL and a current file of all approved reports shall be maintained by the support contractor. (Note, this line item was deleted September 1985.)

8. Provide engineering field support, as required, for experiment buildup, shuttle integration, prelaunch preparation, launch and recovery.

Provide these fixturing/hardware and logistics support for the space simulation test as required. Task to be completed by one month after launch.

9. As required, attend technical and working group meetings between AFGL, USU, and subcontractors. Support under this task will include engineering technical evaluation of components, documentation, resolution of AFGL action items and preparation and/or presentation of material. Task to be completed by one month after launch.

10. Data and reports in accordance with Attachment 2, DD Form 1423, dated 83APR11.

2. SOW TASK ITEMS

2.1 General. This section addresses the work completed on the aforementioned task items.

2.2 Task Item 1. The following was accomplished:

a. SDC maintained CIRRIS integration efforts at the experiment level by establishing and maintaining interface control documentation, SDC TM-2184, CIRRIS-1A Gimbal ICD, with Utah State University (USU), AFGL, and USU subcontractors. SVIC interface requirements (mechanical and electrical) were also established and maintained through the Lockheed Missiles and Space Company (LMSC), LMSC/D84474D, CIRRIS1A Interface Control Document. SDC established many of the constraints incorporated in this document.

b. Detailed failure analysis was completed and incorporated in the Failure Modes Effects Analysis (FMEA), SDC TM-2335. This effort categorized failure modes, so that they may be addressed to reduce the risk of failure and ensure shuttle safety.

c. Electromagnetic interference constraints were also established to ensure that LMSC/CIRRIS-1A emissions and susceptibility were compatible. Compatibility was incorporated into LMSC/D886826, Electromagnetic Compatibility Control Plan.

d. SDC supported interface meetings between AFGL and LMSC through active participation and documenting issues.

2.3 Task Item 2. The following was accomplished:

a. SDC maintained the program mass properties file. Duties included maintaining accurate records of payload weight, calculating mass moments of inertia and products of inertia for both lift-off and landing cases. SDC was also responsible for submitting semi-annual mass property reports to LMSC.

b. SDC performed a detailed power requirements analysis. Power usage was monitored throughout all mode combinations, and with the aid of USU, electrical power requirements were established and incorporated in the CIRRIS-1A ICD LMSC/D844743.

c. SDC supplied USU with specific information on detailed dynamic and thermal models for the CIRRIS-1A program. USU then generated the required models for SVIC integration.

2.4 Task Item 3. SDC generated a detailed overall drawing tree listing (SDC TM-2748, CIRRIS-1A Drawing List) of all CIRRIS-1A flight components and parts to aid in experiment integration and flight operations. All drawing revisions were incorporated in this listing to ensure that the drawing tree was kept up to date.

2.5 Task Item 4. SDC developed the following documents to satisfy SVIC requirements for shuttle integration:

a. SDC TM-2655, Accident Risk Assessment Report

b. SDC TM-2335, Failure Mode Effects Analysis

c. SDC TM-2548, CIRRIS 1A Material List

d. SDC TM-2589, List of Non-Complying Materials

e. SDC TM-2663, CIRRIS 1A Closure Log

2.6 Task Item 5. SDC provided input to numerous LMSC integration documents before CIRRIS-1A was delivered to LMSC. SDC also aided in maintaining compliance with LMSC integration documentation, which included:

a. Interface Control Document (ICD), LMSC/D844743

b. Flight Operations Requirements Document (FORD), LMSC/D888677

c. Ground Operations Requirements Document (GORD), LMSC/L061086

d. Failure Modes Effects Analysis (FMEA), SDC TM-2335

e. Factory Test Requirements, LMSC/D890812A

f. SDC also performed a major role in preparing a key safety document, the CIRRIS-1A Accident Risk Assessment Report (ARAR) SDC TM-2655. SDC provided TM-2655 to the SVIC for incorporation into the payload ARAR (LMSC/D866819). SDC also prepared and delivered presentations to the USAF/NASA Safety Review Teams during the multi-phased safety certification process.

2.7 Task Item 6. The CIRRIS-1A test plans for component, subsystem, and system levels were developed jointly by AFGL/LC and SDC. SDC was instrumental in determining a logical sequence of testing to minimize system integration problems. Space simulation testing plans and procedures, SDC TM-2592, were also developed under this item. SDC maintained interfaces with AFGL and NASA/JPL to ensure that plans and procedures were implemented with minimal discrepancies. This task item was deleted September 1985 at which point support of this item was discontinued.

2.8 Task Item 7. SDC provided engineering test support for component and system level testing. Monitoring tests, tracking malfunction reports and providing general assistance were the major duties covered under component level

testing. This task item was deleted September 1985 at which point support of this item was discontinued.

2.9 Task Item 8. SDC has provided full field support since CIRRIS-1A delivery to USU June 1984. SDC actively participated in integration with the CIRRIS-1A instrument package. Field support was provided throughout space simulation testing at NASA/JPL. SDC also provided field support for integration with LMSC equipment.

SDC's role in the space simulation test was to serve as the principal interface between the CIRRIS-1A experiment parties and NASA/JPL facilities. Duties included planning logistics in preparation of testing, preparation of the test facilities (ie, installing all test equipment), providing a test conductor and test monitors, and fulfilling CIRRIS-1A requirements by coordinating activities at the NASA facilities.

The following test equipment was designed and manufactured, or procured for space simulation testing at NASA/JPL facilities:

Quantity	Description
1	Test Stand, SDC P/N 875-450
3	Pulinex Video Cameras, SDC P.O. No. 9177-6590
3	Camera Mounts, SDC P/N SK-560
4	Beta Cloth Hanging Rods, SDC P/N 875-450
1	Roll Axis Ballast Assembly, SDC P/N 875-532

In November 1986 Air Force Manned Spaceflight Engineers (MSE) reported difficulty in tracking targets. SDC incorporated a series of tests to determine the source of the problem. The problem was narrowed down to an 800 millisecond variable delay from the LMSC Command and Monitor Panel (CMP). SDC developed test software which allowed known delays to be incorporated in the SDC gimbal Ground Support Equipment (GSE) in an effort to determine the maximum delay allowable for MSE tracking operations. The results were used by LMSC to develop new CMP software to correct the delay anomaly. SDC then reprogrammed the SDC GSE to simulate the new CMP software to:

a. Confirm that the new software would allow the MSE to perform the tracking operations.

b. Provide a high fidelity CMP simulator for MSE training, stand alone and joint integrated simulations during CIRRIS-1A off-line testing operations.

Several program meetings and CIRRIS-1A, tracking tests were conducted to ensure that the 800 millisecond variable delay problem had been correctly identified, assessed, and solved.

SDC also incorporated a software change that would prevent the joystick normal rates from decreasing when nearing the gimbal hardstops. The software change maintained constant rates; however, rate transition delays caused further difficulties in tracking. Trade-off testing between new and old software resulted in the decision to continue with the old software.

SDC supported the transportation aspects of the program. This entailed logistically planning transportation efforts to all experiment destinations,

as well as escorting experiment deliveries to all destinations. Support was also given to return CIRRIS-1A to USU after the space shuttle program was placed on hold following the 51-L accident. Further field support included re-delivery of the Dual Axis Pointing System (DAPS) to USU in August 1987.

2.10 Task Item 9. SDC has supported Technical Interchange Meetings (TIM), Independent Readiness Reviews (IRR), Program Management Reviews (PMR) and Safety Reviews throughout the duration of the contract. SDC support included:

a. Generating information for presentation

b. Documenting meeting and review issues

c. Responding to and issuing action items

2.11 Task Item 10. This final report and other Contract Data Requirement Lists (CDRL) as well as documents generated in other task items throughout the duration of the contract met the requirements of Task Item 10.

3. CONCLUSION

3.1 Contract No. F19628-83-C-0156. SDC considers this contract completed because the tasks in the SOW that were not completed were caused by the space shuttle program hold.

END

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